TEXAS INSTRUMENTS
Data sheet acquired from Harris Semiconductor
SCHS036B – Revised July 2003

CD4031B Types

CMOS 64-Stage Static Shift Register

High-Voltage Types (20-Volt Rating)

■ CD4031B is a static shift register that contains 64 D-type, master-slave flip-flop stages and one stage which is a D-type master flip-flop only (referred to as a 1/2 stage).

The logic level present at the DATA input is transferred into the first stage and shifted one stage at each positive-going clock transition. Maximum clock frequencies up to 12 Megahertz (typical) can be obtained. Because fully static operation is allowed, information can be permanently stored with the clock line in either the low or high state. The CD4031B has a MODE CONTROL input that, when in the high state, allows operation in the recirculating mode. The MODE CONTROL input can also be used to select between two separate data sources. Register packages can be cascaded and the clock lines driven directly for high-speed operation. Alternatively, a delayed clock output (CL_D) is provided that enables cascading register packages while allowing reduced clock drive fan-out and transition-time requirements. A third cascading option makes use of the Q' output from the 1/2 stage, which is available on the next negative-going transition of the clock after the Q output occurs. This delayed output, like the delayed clock CL_D, is used with clocks having slow rise and fall times.

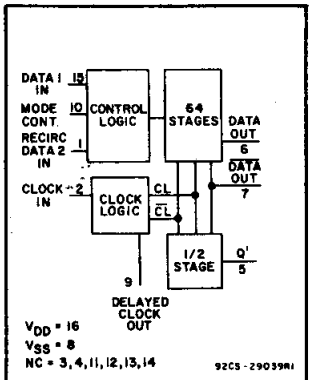
The CD4031B types are supplied in 16-lead hermetic dual-in-line ceramic packages (F3A suffix), 16-lead dual-in-line plastic packages (E suffix), 16-lead small-outline packages (NSR suffix), and 16-lead thin shrink small-outline packages (PW and PWR suffixes).

Features:

- Fully static operation: DC to 12 MHz typ. @ $V_{DD}-V_{SS}$ = 15 V
- Standard TTL drive capability on Q output
- Recirculation capability
- Three cascading modes:
  - Direct clocking for high-speed operation
  - Delayed clocking for reduced clock drive requirements
  - Additional 1/2 stage for slow clocks
- 100% tested for quiescent current at 20 V
- Maximum input current of 1 μA at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- Noise margin (over full package-temperature range)
  - 1 V at V_{DD} = 5 V
  - 2 V at V_{DD} = 10 V
  - 2.5 V at V_{DD} = 15 V
- 5-V, 10-V, and 15-V parametric ratings
- Meets all requirements of JEDEC Tentative Standard No. 13B, "Standard Specifications for Description of 'B' Series CMOS Devices"

Applications:

- Serial shift registers
- Time delay circuits



FUNCTIONAL DIAGRAM

INPUT CONTROL CIRCUIT TRUTH TABLE

DATA	RECIRC.	MODE	BIT INTO STAGE I
1	X	0	1
0	X	0	0
X	1	1	1
X	0	1	0

TYPICAL STAGE TRUTH TABLE

Data	CL	Data + 1
0	⌐	0
1	⌐	1
X	¬	NC

RECOMMENDED OPERATING CONDITIONS
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTIC	LIMITS		UNITS
	Min.	Max.	
Supply-Voltage Range (For T_A=Full Package-Temperature Range)	3	18	V

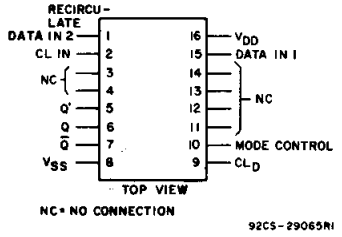
TRUTH TABLE FOR OUTPUT FROM Q' (TERMINAL 5)

Data + 64	CL	Data + 64½
0	¬	0
1	¬	1
X	⌐	NC

1 = HIGH LEVEL 0 = LOW LEVEL
X = DON'T CARE NC = NO CHANGE

MAXIMUM RATINGS, *Absolute-Maximum Values:*

DC SUPPLY-VOLTAGE RANGE, (V_{DD})
(Voltages referenced to V_{SS} Terminal) ..... -0.5V to +20V
INPUT VOLTAGE RANGE, ALL INPUTS ..... -0.5V to V_{DD} +0.5V
DC INPUT CURRENT, ANY ONE INPUT ..... ±10mA
POWER DISSIPATION PER PACKAGE (P_D):
For T_A = -55°C to +100°C 500mW
For T_A = +100°C to +125°C ..... Derate Linearity at 12mW/°C to 200mW
DEVICE DISSIPATION PER OUTPUT TRANSISTOR
FOR T_A = FULL PACKAGE-TEMPERATURE RANGE (All Package Types) 100mW
OPERATING-TEMPERATURE RANGE (T_A) ..... -55°C to +125°C
STORAGE TEMPERATURE RANGE (T_{stg}) ..... -65°C to +150°C
LEAD TEMPERATURE (DURING SOLDERING):
At distance 1/16 ± 1/32 inch (1.59 ± 0.79mm) from case for 10s max ..... +265°C



TERMINAL ASSIGNMENT

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
	V_O (V)	V_{IN} (V)	V_{DD} (V)	−55	−40	+85	+125	+25 Min.	+25 Typ.	+25 Max.	
Quiescent Device Current, I_{DD} Max.	–	0,5	5	5	5	150	150	–	0.04	5	μA
	–	0,10	10	10	10	300	300	–	0.04	10	
	–	0,15	15	20	20	600	600	–	0.04	20	
	–	0,20	20	100	100	3000	3000	–	0.08	100	
Output Low (Sink) Current I_{OL} Min. Q	0.4	0,5	5	2.56	2.44	1.68	1.44	2.04	4	–	mA
	0.5	0,10	10	6.4	6	4.4	3.6	5.2	10.4	–	
	1.5	0,15	15	16.8	16	11.2	9.6	13.6	27.2	–	
$\overline{Q}$, Q', CL_D	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1	–	
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	–	
	1.5	0,15	15	4.2	4	2.8	2.4	3.4	6.8	–	
Output High (Source) Current, I_{OH} Min. Q, $\overline{Q}$, Q', CL_D	4.6	0,5	5	−0.64	−0.61	−0.42	−0.36	−0.51	−1	–	
	2.5	0,5	5	−2	1.8	−1.3	−1.15	−1.6	−3.2	–	
	9.5	0,10	10	−1.6	−1.5	−1.1	−0.9	−1.3	−2.6	–	
	13.5	0,15	15	−4.2	4	−2.8	−2.4	−3.4	−6.8	–	
Output Voltage: Low-Level, V_{OL} Max.	–	0,5	5	0.05				–	0	0.05	V
	–	0,10	10	0.05				–	0	0.05	
	–	0,15	15	0.05				–	0	0.05	
Output Voltage: High-Level, V_{OH} Min.	–	0,5	5	4.95				4.95	5	–	
	–	0,10	10	9.95				9.95	10	–	
	–	0,15	15	14.95				14.95	15	–	
Input Low Voltage V_{IL} Max.	0.5, 4.5	–	5	1.5				–	–	1.5	V
	1,9	–	10	3				–	–	3	
	1.5, 13.5	–	15	4				–	–	4	
Input High Voltage, V_{IH} Min.	0.5, 4.5	–	5	3.5				3.5	–	–	
	1,9	–	10	7				7	–	–	
	1.5, 13.5	–	15	11				11	–	–	
Input Current I_{IN} Max.		0,18	18	±0.1	±0.1	±1	±1	–	$\pm 10^{-5}$	±0.1	μA

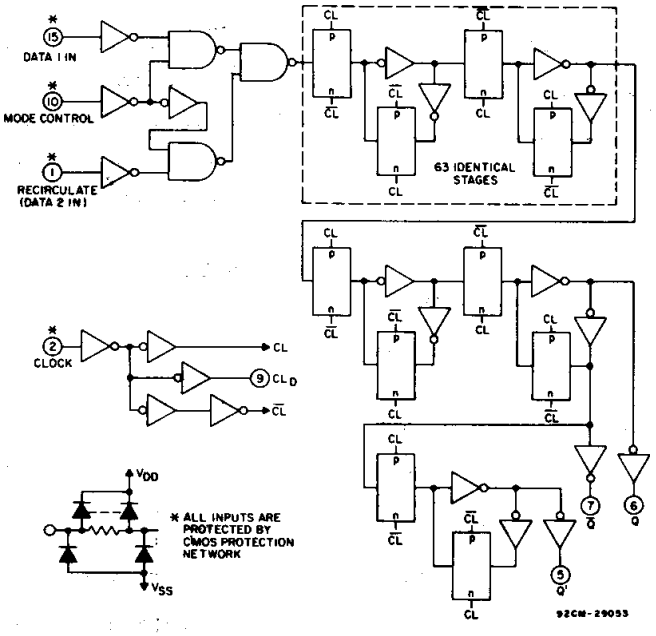


Fig. 1 – Logic diagram.

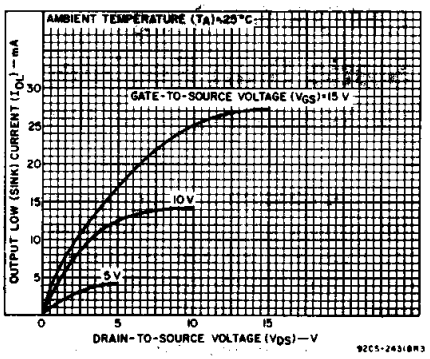


Fig. 2 – Typical output low (sink) current characteristics (Q sink current = 4X ordinate).

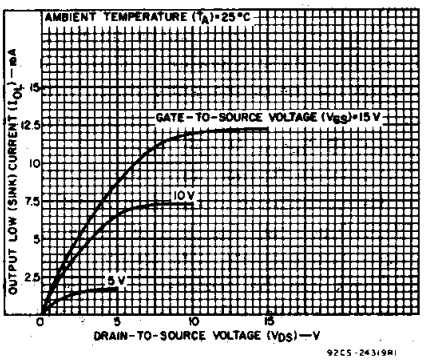


Fig. 3 – Minimum output low (sink) current characteristics (Q sink current = 4X ordinate).

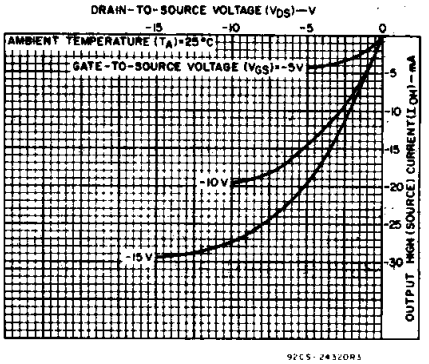


Fig. 4 – Typical output high (source) current characteristics.

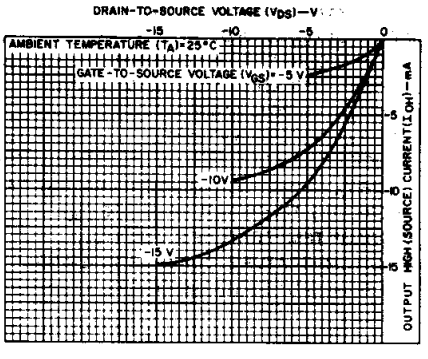


Fig. 5 – Minimum output high (source) current characteristics.

DYNAMIC ELECTRICAL CHARACTERISTICS *at $T_A = 25^oC$; Input $t_r, t_f = 20$ ns, $C_L = 50$ pF, $R_L = 200$ kΩ*

CHARACTERISTIC	TEST CONDITIONS V_{DD}(V)	LIMITS Min.	Typ.	Max.	UNITS
Propagation Delay Time: Clock to $\overline{Q}$, t_{PHL}, t_{PLH}; Clock to Q, t_{PLH}	5	–	250	500	ns
	10	–	110	220	
	15	–	90	180	
$\overline{\text{Clock}}$ to Q', t_{PHL}, t_{PLH}; Clock to Q, t_{PHL}	5	–	190	380	ns
	10	–	80	160	
	15	–	65	130	
Clock to CL_D	5	–	100	200	ns
	10	–	50	100	
	15	–	40	80	
Transition Time, t_{THL}, t_{TLH} (Any Output, except Q, t_{THL})	5	–	100	200	ns
	10	–	50	100	
	15	–	40	80	
Q, t_{THL}	5	–	50	100	ns
	10	–	25	50	
	15	–	20	40	
Minimum Data Setup Time, t_S	5	–	30	60	ns
	10	–	15	30	
	15	–	10	20	
Minimum Data Hold Time, t_H	5	–	30	60	ns
	10	–	15	30	
	15	–	10	20	
Minimum Clock Pulse Width, t_W	5	–	120	240	ns
	10	–	50	100	
	15	–	40	80	
Maximum Clock Input Frequency, f_{CL}**	5	2	4	–	MHz
	10	5	10	–	
	15	6	12	–	
Clock Input Rise or Fall Time, t_{rCL}, t_{fCL}*	5	–	–	1000	μs
	10	–	–	1000	
	15	–	–	200	
Input Capacitance, C_{IN} (Any Input)	–	–	5	7.5	pF

*If more than one unit is cascaded in the parallel clocked application, t_rCL should be made less than or equal to the sum of the propagation delay at 50 pF and the transition time of the output driving stage.

**Maximum Clock Frequency for Cascaded Units;

a) Using Delayed Clock Feature in Recirculation Mode:

$$f_{max} = \frac{1}{(n-1)\,CL_D \text{ prop. delay} + Q \text{ prop. delay} + \text{set-up time}}$$ where n = number of packages

b) Not Using Delayed Clock:

$$f_{max} = \frac{1}{\text{propagation delay} + \text{set-up time}}$$

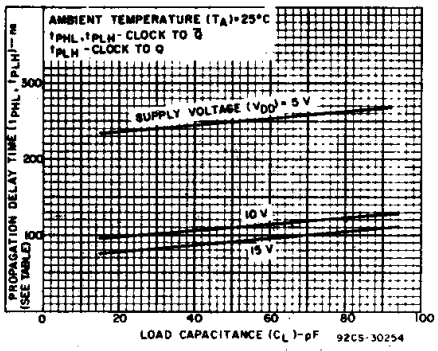


Fig. 6 – Typical propagation delay time as a function of load capacitance (see table).

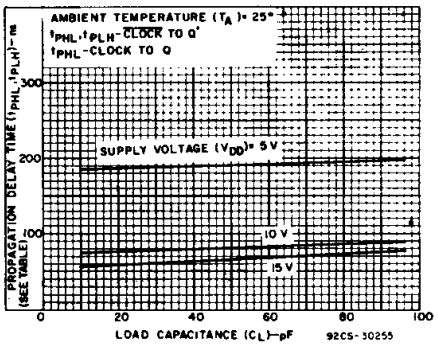


Fig. 7 – Typical propagation delay time as a function of load capacitance (see table).

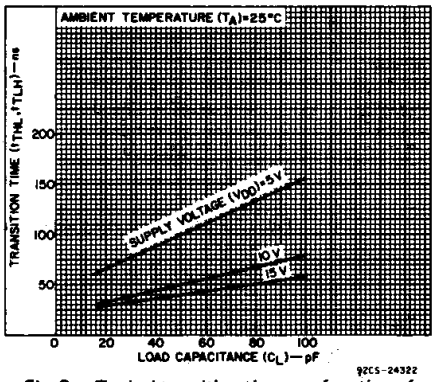


Fig. 8 – Typical transition time as a function of load capacitance (except Q, t_{THL}).

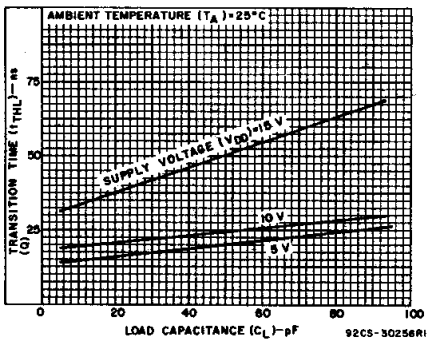


Fig. 9 – Typical transition time as a function of load capacitance (Q, t_{THL}).

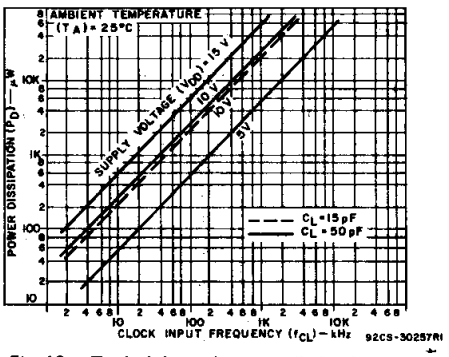


Fig. 10 – Typical dynamic power dissipation as a function of clock input frequency.

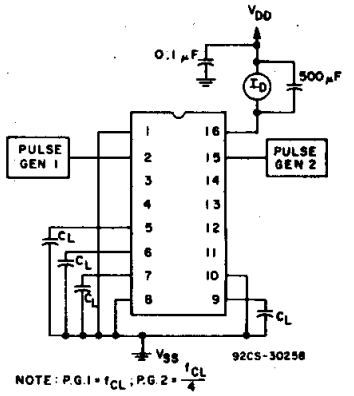


Fig. 11 – Dynamic power dissipation test circuit.

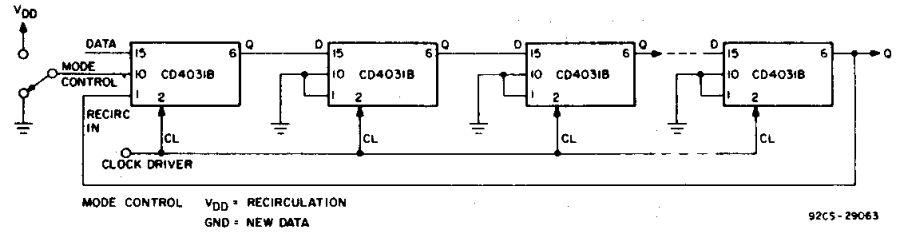


Fig. 12 – Cascading using direct clocking for high-speed operation (see clock rise and fall time requirement).

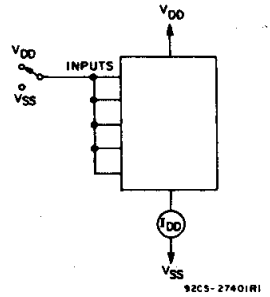


Fig. 13 – Quiescent-device-current test circuit.

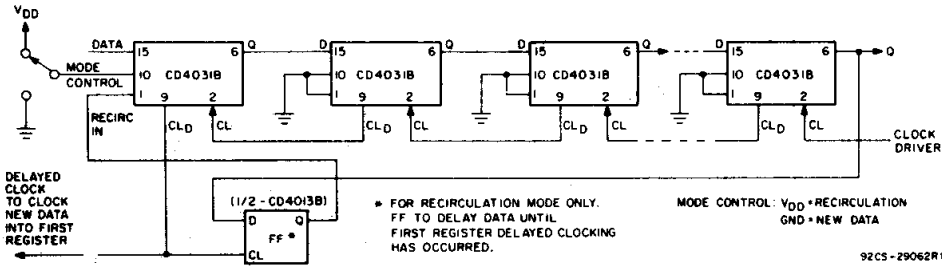


Fig. 14 – Cascading using delayed clocking for reduced clock drive requirements.

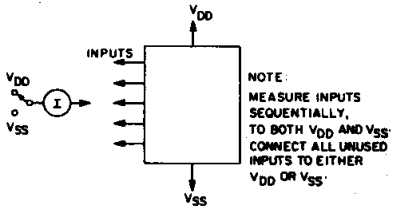


Fig. 15 – Input-leakage current.

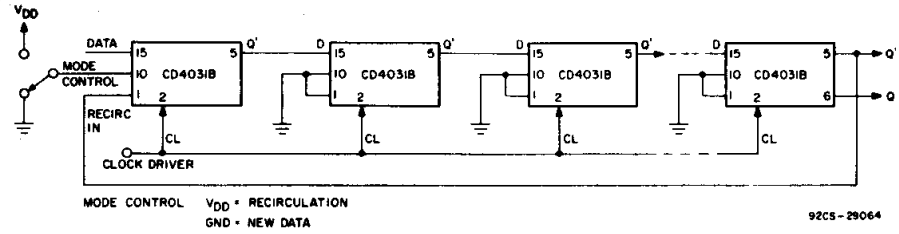


Fig. 16 – Cascading using half-clock-pulse delayed data output (Q') to permit use of slow rise and fall time clock inputs.

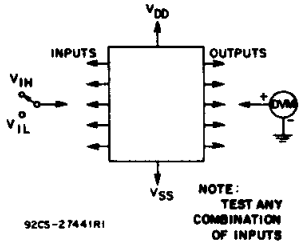
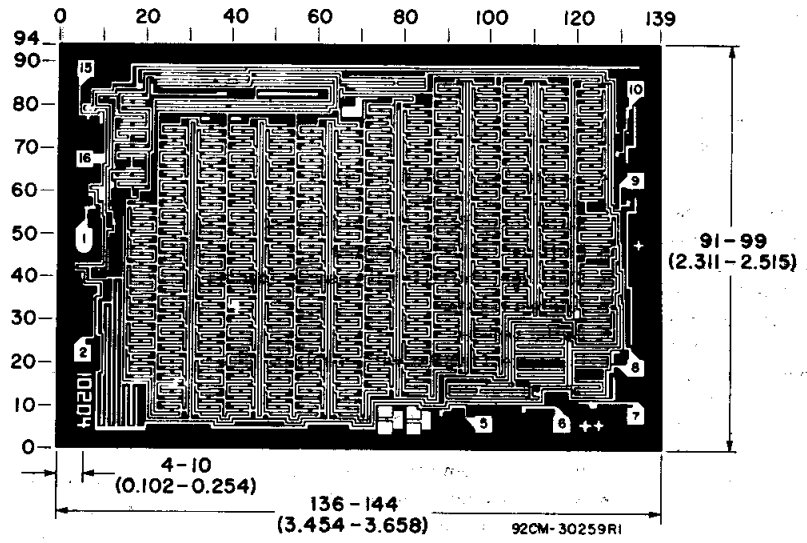


Fig. 17 – Input-voltage test circuit.



Chip dimensions and pad layout for CD4031B

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated. Grid graduations are in mils (10^{-3} inch).

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
CD4031BE	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
CD4031BEE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
CD4031BF3A	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	N / A for Pkg Type
CD4031BNSR	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BNSRE4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BNSRG4	ACTIVE	SO	NS	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BPWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BPWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4031BPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

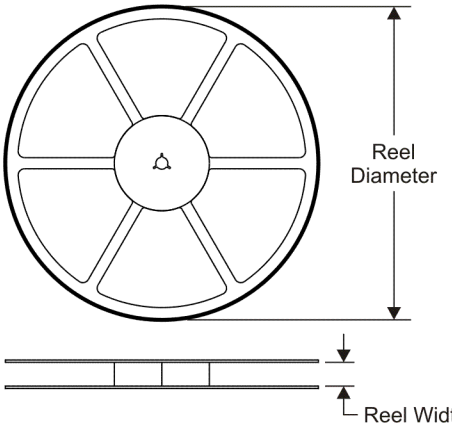
[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

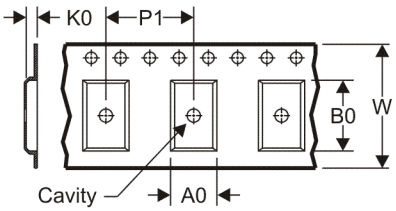
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

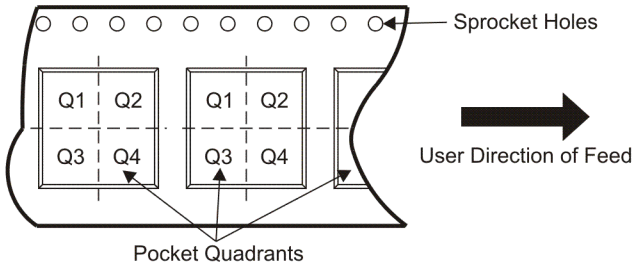


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

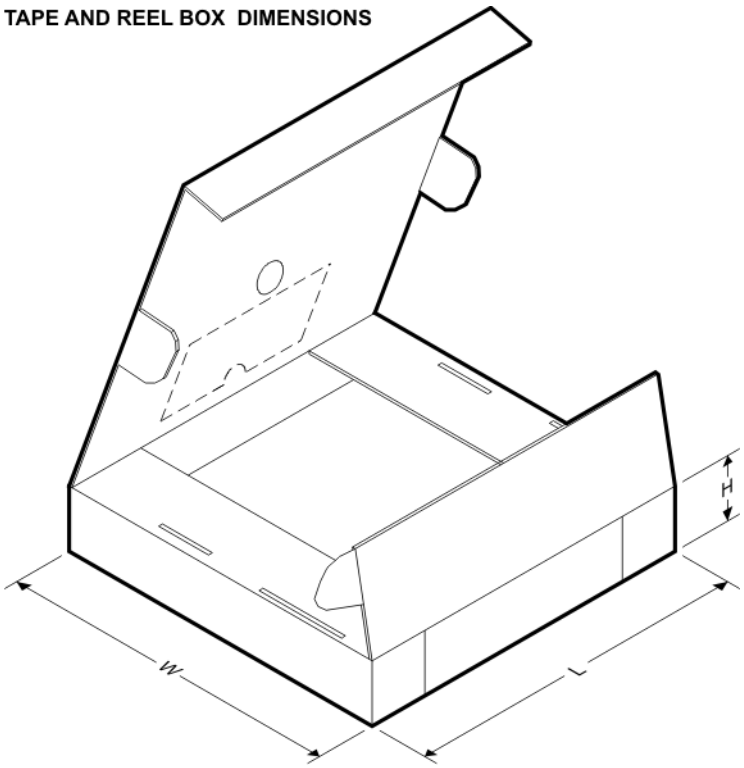
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CD4031BNSR	SO	NS	16	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
CD4031BPWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

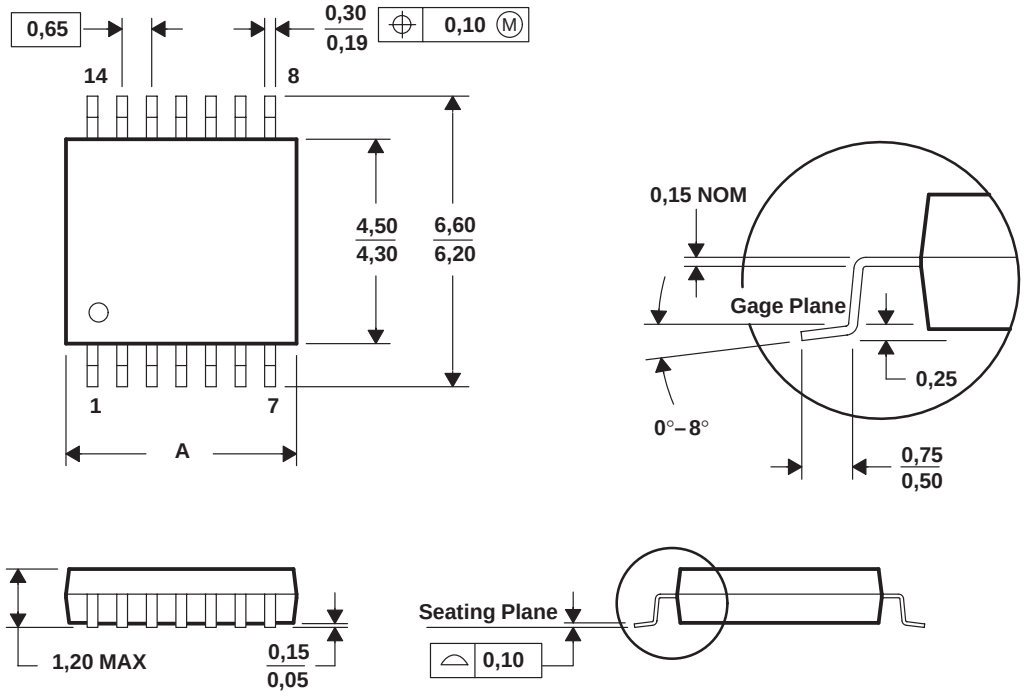


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CD4031BNSR	SO	NS	16	2000	346.0	346.0	33.0
CD4031BPWR	TSSOP	PW	16	2000	346.0	346.0	29.0

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

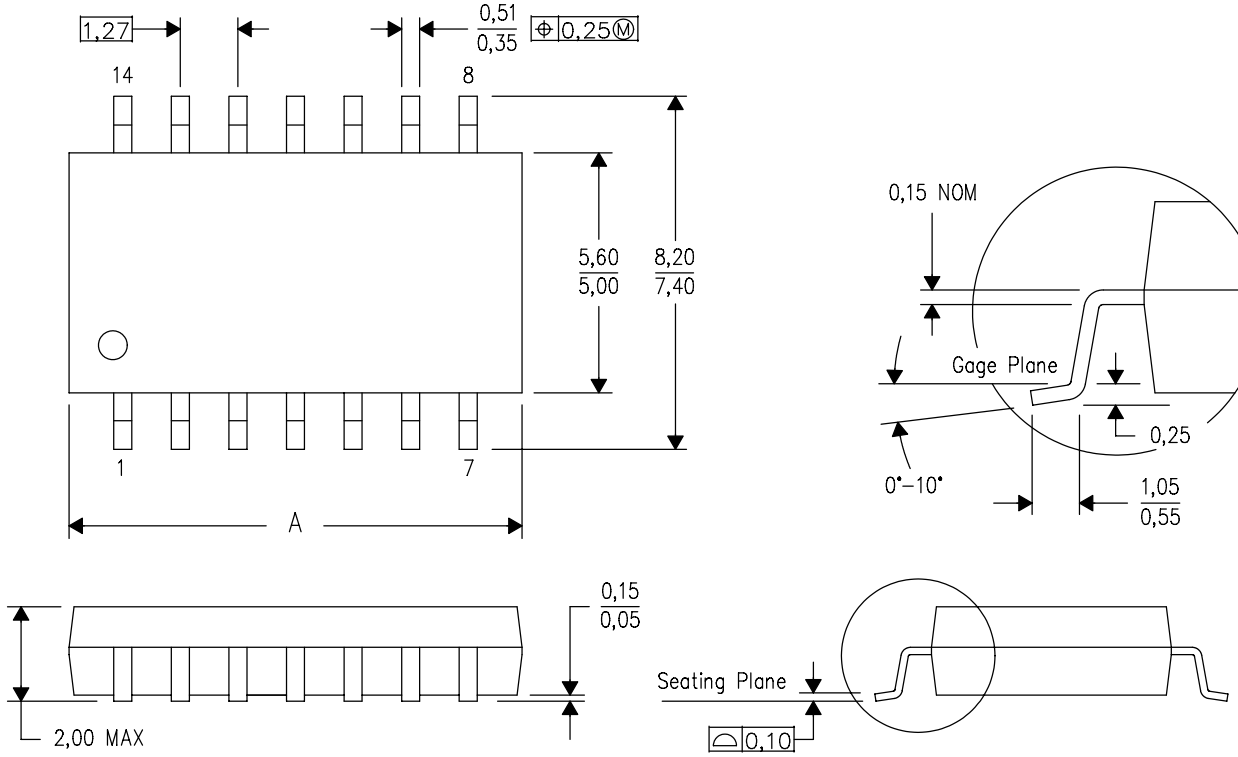
4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

MECHANICAL DATA

NS (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14-PINS SHOWN



DIM \ PINS **	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

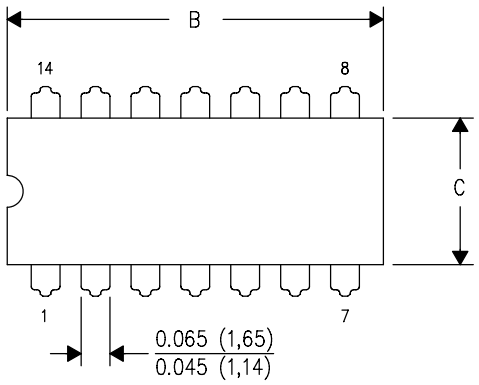
4040062/C 03/03

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

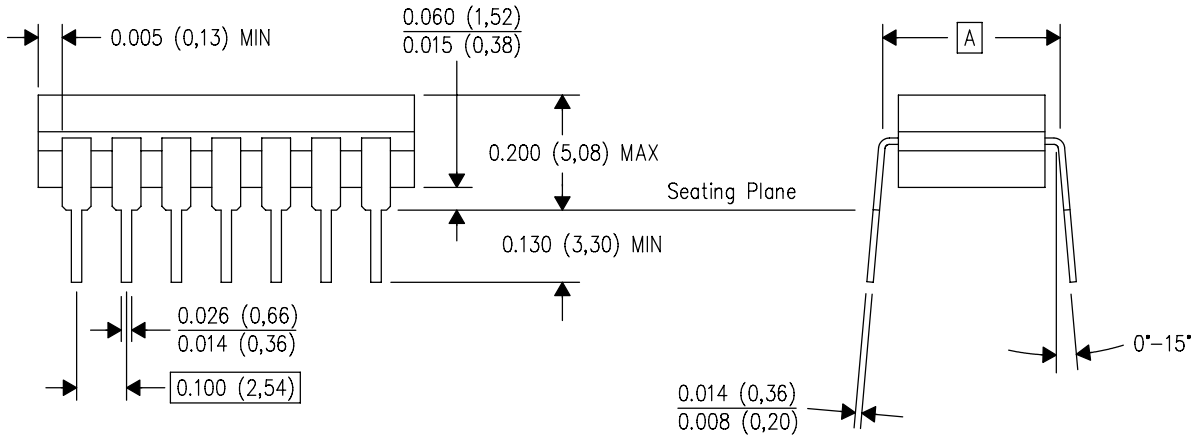
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



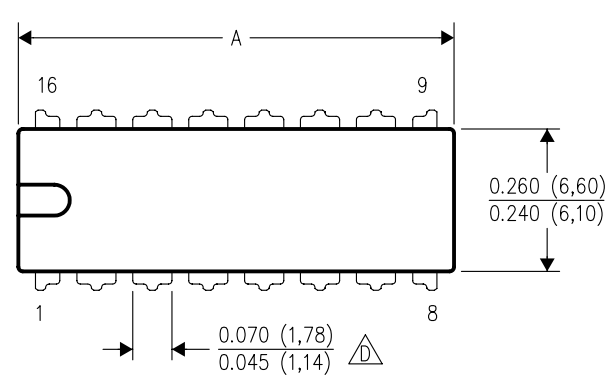
4040083/F 03/03

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

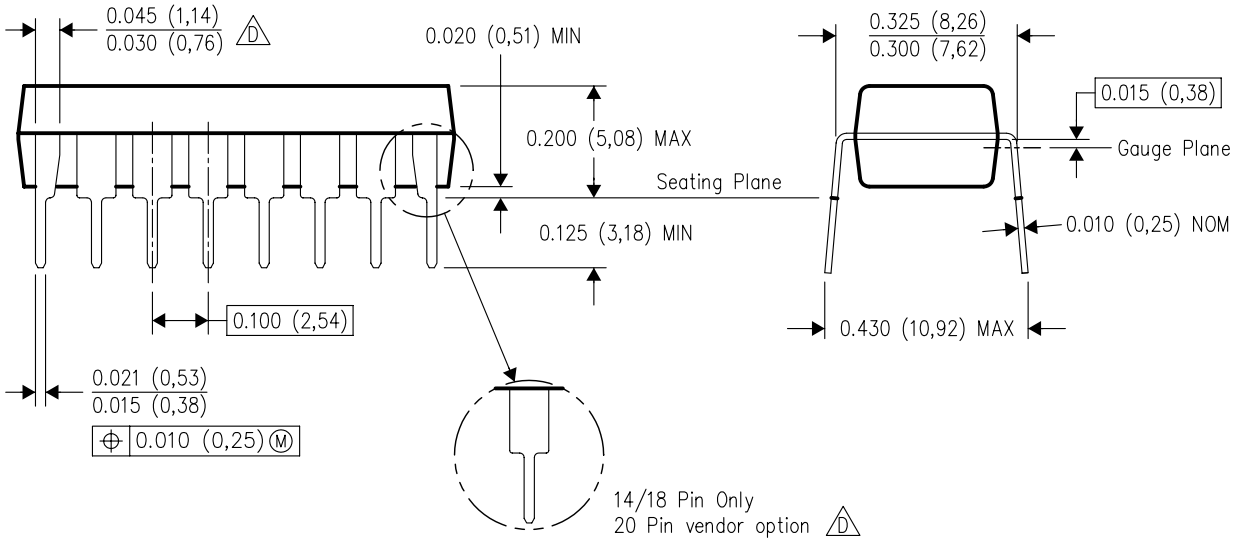
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

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